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Improving safety culture through the health and safety organization: A case study

Kent J. Nielsen *

Danish Ramazzini Center, Herning Regional Hospital, Department of Occupational Medicine, Gl. Landevej 61, DK-7400 Herning, Denmark

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ABSTRACT

Introduction: International research indicates that internal health and safety organizations (HSO) and health and safety committees (HSC) do not have the intended impact on companies' safety performance. The aim of this case study at an industrial plant was to test whether the HSO can improve company safety culture by creating more and better safety-related interactions both within the HSO and between HSO members and the shop-floor. *Methods:* A quasi-experimental single case study design based on action research with both quantitative and qualitative measures was used. *Intervention:* Based on baseline mapping of safety culture and the efficiency of the HSO three developmental processes were started aimed at the HSC, the whole HSO, and the safety representatives, respectively. *Results:* Results at follow-up indicated a marked improvement in HSO performance, interaction patterns concerning safety, safety culture indicators, and a changed trend in injury rates. These improvements are interpreted as cultural change because an organizational double-loop learning process leading to modification of the basic assumptions could be identified. *Practical applications:* The study provides evidence that the HSO can improve company safety culture by focusing on safety-related interactions.

1. Introduction

1.1. Safety culture

There is a conspicuous lack of culture change intervention studies in the safety literature (DeJoy, 2005; Hale, Guldenmund, van Loenhout, & Oh, 2010), which might be due to the fact that the theoretical framework for safety culture generally is underdeveloped and the link to research on organizational culture has been weak or even nonexisting (Choudhry, Fang, & Mohamed, 2007; Clarke, 2000). There is, for instance, no widely accepted model of safety culture or any consensus on how to define or describe the safety culture of an organization. Therefore, the concept of safety culture is vague and not easily translated into change efforts. One possible way to remedy this is to see safety culture as an integrated part of the more general concept of organizational culture. Specifically, safety culture can be understood as the aspects or parts of the organizational culture that influence attitudes and behaviors, which have an impact on the level of safety in the organization (Hale, 2000).

Schein (1990, 2004) defines organizational culture as a pattern of shared basic assumptions that a group has learned as it solved issues of external adaptation and internal integration. These basic assumptions are not readily observable or measurable as they are unconscious, taken-for-granted beliefs that are the ultimate source of values and actions. In Schein's understanding basic assumptions are similar to 'theories-in-use' (Argyris & Schön, 1996), which are the implicit assumptions that actually guide behavior. The identification of these basic underlying assumptions is not easy. It is an analytical process based on the two other cultural layers that are more accessible: artifacts (visible organizational structures and processes that are easy to observe but hard to decipher) and espoused beliefs and values (strategies, goals and philosophies that serve as the espoused justifications for actions and are similar to 'espoused theories' (Argyris & Schön, 1996)).

Schein argues that organizational culture can be changed intentionally given the right circumstances and initiatives. Culture is seen as a stabilizing force that serves an anxiety reducing function, as it gives people a frame of reference for how to act, think, and feel in new situations. In that sense culture is a learned defense mechanism against uncertainty and change (Schein, 2004). Therefore, cultural change is an anxiety-provoking process that is only undertaken if there is a large enough motivation to change. This might be the case if the organization senses a large enough threat, crisis, or dissatisfaction with the current state of affairs to warrant a change in its basic assumptions. Such deep change requires double-loop learning rather than single-loop learning (Argyris & Schön, 1996), which only changes the outer layer of the culture.

1.2. Using safety climate to change safety culture

The fuzziness of the culture concept and the unconscious nature of the basic assumptions make it difficult to influence culture directly. One way

* Corresponding author. Tel.: +45 2367 1399; fax: +45 7843 3518.
E-mail address: kennie@rm.dk.

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to approach culture change could be by looking at the related concept of climate, which describes the shared perceptions of organizational policies, practices, and procedures, both formal and informal (Reichers & Schneider, 1990). The differences (or lack of difference) between the climate and culture concepts have been widely debated both within organizational theory and safety science (Guldenmund, 2000; Reichers & Schneider, 1990). However, although both concepts are understood as some sort of shared perceptions that are created over time, culture is generally seen as a more abstract and stable construct than climate, that more easily lends itself to manipulation (Guldenmund, 2000). In Schein's understanding, organizational climate is a surface manifestation of the deeper cultural levels and a reflection of leaders' attempts to embed culture (Schein, 2004). Thus, climate can be seen as an entrance door to work with culture, as it is a visible (and more measurable) concept that is tied to the creation of culture.

Within safety science, Dov Zohar has proposed that safety climate is formed by the workers' perception of the relative priority of safety versus efficiency goals in supervisory practices (Zohar, 2000). Theoretically, this installs supervisory safety practices as a link between safety climate and culture. Supervisory practices are guided by supervisors' basic assumptions (culture) and are taken as guiding principles for employee actions as they are perceived by employees (climate). Of course, not every supervisory practice is directly guided by basic assumptions, as many other behavioral influences exist. However, the formation of climate and culture is not rooted in any single instance of supervisory practice, but relates to the general pattern of priorities in supervisory practices over time. Thus, creating a sustained change in supervisory practices becomes a way to put safety climate and culture change into practice.

This approach to change is primarily leader-based, as it focuses on changing supervisory practices, which is in accordance with Schein's (2004), Zohar (2000, 2002a, 2002b), and Zohar and Luria (2003) emphasis on the pivotal role of leaders in creating cultural and climate change. This is not surprising, as management's commitment to safety is generally acknowledged as a fundamental aspect of successful safety performance (O'dea & Flin, 2001; Rundmo & Hale, 2003; Simard & Marchand, 1995). However, neither organizational nor cultural change is a prescriptive linear top-down process. Rather it involves unpredictable complex social processes (Dooley, 1997). It has recently been suggested to apply insights from complexity theories to safety (Rosa Antonia, 2011), and although there exist no unified complexity theory or approach (Horgan, 1995), complex adaptive systems theory delivers a comprehensive understanding of organizational change (Dooley, 1996, 1997). Within complex adaptive systems, theory interactions are seen as the driver of organizational change, which is in agreement with Zohar's emphasis on the daily interactions between management and workers as the building blocks of climate change. However, complex adaptive systems theory states that control over such changes lie in the organization as a whole and not within any single individual (e.g., the leader; Dooley, 1996). Complex adaptive systems theory focuses on the unpredictable and uncontrollable nature of change processes and self-organization takes center stage in the change process (Dooley, 1996, 1997). Self-organization is seen as a process by which novel and unpredictable order emerges from the interactions between distinctive agents. Hence, leaders are not in full control of change processes and cannot predict the outcome of changes. Thus, change cannot be implemented top-down, but instead emerges out of the pattern of interactions between the individuals in the organization. However, leaders have the opportunity to influence the change process at the macro-level by enabling or restricting the possibilities for individuals to interact, and thereby catalyze, create, or hinder relationships (Marion & Uhl-Bien, 2001).

Hence, by combining theories on organizational culture, (safety) climate and complex adaptive systems, it is feasible that cultural change can be created by changing the pattern of interactions between organizational members.

1.3. Health and safety organizations and committees

In many organizations the health and safety organization (HSO) or committee (HSC) is placed as the pivotal point of organizational safety efforts and could therefore be the natural breeding ground for safety culture change. However, as there is no uniform international legislation regarding the establishment of HSOs or HSCs, it is difficult to compare experiences between countries. Most research on the effectiveness of HSCs has been conducted in the United States (Milgate, Innes, & O'Loughlin, 2002) and although evidence from there indicate that HSCs tend to have a positive effect on company safety performance (Parker et al., 2007; Smitha, Kirk, Oestenstad, Brown, & Lee, 2001), international evidence suggests that HSCs have had difficulties in promoting safety (Frick & Wren, 2000) and that the creation of HSCs does not have an effect on injury rates in itself, but depends on the structure (size and composition), process (participation, involvement), and activities (executive functions and training of committee members) of the committee (Geldart, Smith, Shannon, & Lohfeld, 2010; Liu et al., 2010; Morse, Goyzueta, Curry, & Warren, 2008). Likewise, a review of international studies on the effectiveness of HSCs concludes that fundamental factors for effective performance include management commitment, communication, the inclusion of safety on the everyday management agenda, committee processes (frequency of meetings, size of committee and problem solving ability), and the involvement of professional experts (Milgate et al., 2002).

In Denmark the Danish Work Environment law specifies how HSOs and HSCs are to be structured. At the time of this study companies with more than five employees were obliged to establish a HSO. The HSO consisted of a representative of top management and so-called 'safety-groups' made up of an employee-elected safety representative and a supervisor for each major work area. The safety-groups should handle the daily safety-issues within their work area. Furthermore, companies with more than 20 employees were obligated to establish a HSC, as a subgroup within the HSO, consisting of the representative of top management and typically two safety representatives and two supervisors (if a company had less than three safety-groups then the HSC would equal the HSO). The HSC should meet four times a year to discuss company safety issues, and two of these meetings should include all members of the HSO.

The most common problems with the HSOs in Denmark are their dependence on a few highly committed individuals, a reactive approach, and a lack of systematic action (Hasle & Langaa Jensen, 2006). At the same time the HSO often lacks integration within the core activities of the company (i.e., production), which in turn leads to insufficient managerial attention. This lack of integration might partly be due to the fact that the creation, structure, and function of the HSO in Denmark is based on national legislation and not on an assessment by company management of how company safety issues are most effectively managed. As such the HSO is created in parallel to the formal organization of the company, which is (typically) formed around the production process. This might push the HSO into a side-car role, where safety issues are deliberately disengaged from production issues, because of the existence of the HSO. This is actually the opposite of the intention of the legislation, but de facto often the case.

1.4. Aim

The aim of the current study is to test whether the HSO can improve company safety culture by creating more and better safety-related interactions both within the HSO and between HSO members and the shop-floor. This is done by starting three developmental processes in the company aimed at the HSC, the whole HSO, and the safety representatives, respectively. The hypothesis is that these developmental processes will create a more active and visible HSO engaging in more and better safety-related interaction, which in turn should result in improvements in safety culture indicators.

2. Methods

2.1. Study design and participants

The study was based on an action research approach, which sees research as an interactive participatory process between the researcher and the object under study. It was designed as a quasi-experimental single case study with baseline and follow-up measurements 23 months apart. This was chosen because a flexible design was needed to accommodate the study's complex adaptive systems approach to organizational change. As action research, quasi-experiments and case studies all allow (and even encourage) the researcher to adapt the study as the intervention processes develop, they are well suited for a complex adaptive systems approach (Anderson, Crabtree, Steele, & McDaniel, 2005).

The study took place at a Danish industrial plant producing large industrial lifts. Besides the approximately 275 workers, the study population consisted of the company's five supervisors, the safety manager, the production manager, and the CEO. The company's HSO consisted of five safety-groups (employee elected safety representatives teamed with supervisors), the safety manager, and the production manager. At baseline the company's HSC consisted of the production manager, the safety manager, two of the safety representatives, and the company's building inspector.

2.2. Multi-method approach

The study used a multi-method approach consisting of document analysis, observations, registration of safety-related interactions, semi-structured interviews, and a questionnaire.

Semi-structured interviews were performed at baseline and follow-up with three groups of four employees, all safety representatives, all supervisors, the safety manager, the production manager, and the CEO. The employees where randomly selected by the researcher and the same employees were interviewed at both baseline and follow-up. The interviews took from 1 to 1 and 1/2 h each and focused on seven superordinate themes (e.g., knowledge of safety issues, risk behavior, perception of the HSO, and priority of safety). They were subsequently analyzed in Nvivo v.7 software using Template Analysis (King, 2005). Template analysis is a method where textual data is coded according to a priori themes (in this case the seven superordinate themes) that are modified and added to as the researcher reads and interprets the texts.

Questionnaires containing scales on HSO performance and safety culture were administered to all workers at baseline and at follow-up. At baseline 248 of 272 workers completed the questionnaire (91.2%). At follow-up 229 of 283 workers participated (80.9%). Of the 272 workers at baseline, 227 where still employed at the company at follow-up. Of these 169 (74.4%) completed the questionnaire both times. The data reported here is from this group, who all were male and at follow-up had a mean age of 45.6 years (SD = 10.3), and a mean seniority at the plant of 11.4 years (SD = 8.9). Analysis of the nonparticipants at baseline showed that they were on average 9.1 years younger ($p < .01$) and had 4.2 years less seniority ($p < .05$) than participants. The participants, who dropped out during the study period, did not differ from completers.

2.3. Measures of activities of the HSO and HSC

The activities of the HSO and HSC were measured by document analysis and questionnaire. Written minutes of meetings in the HSC are required by legislation from compulsory meetings. These were collected for the three years prior to the study and the two study years. They were analyzed as a measure of activities and efficiency of the HSC. This was done by a simple count of number of meetings, the number of issues resolved, and unique issues dealt with per year and meeting.

The questionnaire contained four scales measuring HSO performance taken from an early version of the Danish Safety Culture Questionnaire (Nielsen & Mikkelsen, 2007). 'Feedback' from HSO was measured using four items describing workers perception of HSO's reaction to reported accidents (alpha[1] = .86). Sample item: 'When we report an accident, we receive feedback afterwards.' 'Safety instruction' was measured with three items covering the adequacy of safety training (alpha = .82). Sample item: 'I have been shown how to perform my work safely at my current place of work.' 'Involvement of workers' was measured with a four item scale covering whether workers perceived that their safety inputs were taken seriously by the HSO (alpha = .75). Sample item: 'My inputs on safety issues are not considered.' 'Commitment of the safety representative' was measured with five items (alpha = .93). Sample item: 'My safety representative often takes time to discuss safety issues with me and my co-workers.'

2.4. Measures of safety-related interactions

To map the informal safety-related interactions, all members of the HSO (the production manager, the supervisors, and the safety representatives)[2] were instructed to register all safety-related interactions that they participated in for a month three times during the study period: baseline (BL), midway (MW), and follow-up (FU). A safety-related interaction was defined as any interaction where safety was in some way mentioned. So safety did not need to be the main topic of the interaction, but could just be touched upon briefly either verbally or non-verbally (e.g., a gesture telling a worker to put on personal protective equipment). Every single safety-related interaction had to be registered on a short questionnaire containing information on date, time, place, duration, interaction partners, and general content of the interaction. If a day passed with no safety-related interactions, they only filled out the date and ticked off a box labeled "No safety-related interactions today." If they were absent due to time off or sick leave they ticked off a box specifying this. By design this method only covered interactions where the participants were aware of safety issues being discussed, and does not include interactions where safety implications were unknown at the time of the interaction.

The response rate was calculated as the number of days where at least one questionnaire was filled out compared to the number of days where a questionnaire should have been filled out. At baseline, the response rate was 96%, midway it was 89%, and at follow-up 98%.

Ninety percent of the registered interactions had only two participants. To simplify data analysis the remaining interactions were recoded by splitting them up into dyads. For instance, a single interaction between a safety representative, a supervisor, and a worker, would be recoded into three dyads (supervisor–safety representative, supervisor–worker, safety representative–worker).

2.5. Measures of safety culture

The concept of safety culture is not easy, or perhaps even possible, to operationalize. The scientific field is abundant with more or less conflicting definitions and understandings (Choudhry et al., 2007; Guldenmund, 2000). The current project uses Schein's understanding of organizational culture to model safety culture, which means looking at three different layers of culture (artifacts, espoused values, and basic assumptions). The two outmost layers were each operationalized using a multi-method approach combining both quantitative and qualitative data. This was done because it is not an exact science to measure and understand a

[1] All cited alpha values are from the current study.

[2] The company's safety manager did also participate in the registration of safety-related interactions, but the data is not reported here, as he was replaced midway through the study and the job redefined from a full-time safety manager to a part-time job, that a supervisor had to take care of on top of his supervisor job. So the role was markedly different from baseline to follow-up and a comparison over time would not be true and fair.

complex social construct such as (safety) culture, and no single indicator can capture it precisely. Instead, the approach taken was to establish a multitude of different indicators, and then try to identify (parts of) culture by interpreting the pattern of results across indicators.

As shown in Table 1, the artifact level of the (safety) culture was operationalized as behavioral indicators, structural conditions, documents, and safety climate. The espoused values were operationalized as attitudes toward safety and structural conditions. The basic assumptions were then deduced at baseline and follow-up based on analysis of the artifacts and espoused values.

At the artifact level, *behavioral indicators* were measured by interviews and three scales in the questionnaire. 'Convenience violations' of the workers was measured with three items (alpha = .86) taken from the general unsafe behavior factor from the Offshore Safety Questionnaire (Mearns, Whitaker, & Flin, 2003). 'Top management commitment to safety' was measured using a four item scale (alpa = .74). Sample item: 'Top management puts productivity over safety.' 'Safety specific transformational leadership' was measured using a 20 item scale (Barling, Loughlin, & Kelloway, 2002) describing a single factor (alpha = .96) (Avolio, Bass, & Jung, 1999; Bass & Riggio, 2006).

Structural conditions were measured using document analysis of inspection reports and the written minutes of meetings of the HSO. *Documents* were measured using direct observation by the researcher to identify visible safety information, whereas signposting and safety standards of equipment and machinery were observed by external bodies such as health and safety advisors and inspectors from the Work Environment Authorities (copies of company reports from and correspondence with these external bodies were obtained from the safety manager by the researcher). Finally, *safety climate* was measured using Zohar's (2000) two five item scales covering 'Supervisor expectations' and 'Supervisor actions' (alpha = .88 and .87, respectively). Two items in the latter scale were replaced based on pilot-testing showing higher factor loadings for modified items.

At the espoused values level, *structural conditions* and *attitudes* were measured through observation and interviews combined with three scales in the questionnaire tapping into attitudes toward safety. 'Workers safety priority' was measured using three items (alpha = .79). Sample item: 'I always follow safety guidelines.' 'Safety oversights' was measured with three items covering reasons not to bring up safety issues with supervisors (alpha = .83). Sample item: 'It is of no use to bring up safety issues.' 'Organizational value of safety' was a five item scale developed to measure the perceived importance of safety. It was inspired by safety motivation scales, especially Neal, Griffin, and Hart's (2000) and modified to focus on the organizational level (alpha = .89). Sample item: 'It means a lot for the company to continuously minimize the risk of accidents and injuries.' Furthermore whether there was a feeling of joint responsibility for safety in the departments was measured with a five item scale called 'Shared safety responsibility' (alpha = .72). Two of the items were taken from Cheyne, Oliver, Tomás, and Cox's (2002) Personal involvement scale. Sample item: 'In our department, we help each other to work safely.'

2.6. Lost time injury rates

In Denmark companies are obliged by law to report injuries that cause absence from work on the day after the injury to the Working Environment Authorities. Company injury records were collected from the official reporting system for the four years prior to the study and the two study years. Administrative records of total number of hours worked per month covering the same time period were also collected and thus lost time injury rates (injuries/million hours worked) could be calculated for each year.

2.7. Statistical analyses

Paired t-tests performed in SPSS for Windows v. 15.0 were used to identify changes from baseline to follow-up in the questionnaire scales. Scale scores were calculated by adding the scores on individual items and dividing by the number of items in the scale, giving a scale from 1 to 5. All items and scales were coded such that a high score indicated a good rating.

Poisson regression was used to analyze the development in the number of safety-related interactions, which gives an incidence rate ratio (IRR) describing the number of safety-related interactions compared to the number of registered work days. However, using IRR the three data points are not treated as following a time line, but instead as three separate and independent data points. A simpler model, that takes account of the continuous nature of the data, is to model the changes over all three points using a straight line. Whether or not a straight line describes the relationship between the data points can be tested using a Likelihood Ratio test (LR-test). A non-significant LR-test shows that the linear model fits the data just as well as the model

Table 1
Safety culture indicators and measures.

Cultural layer	Indicators	Measures
Artifacts	*Behavioral indicators*	
	Unsafe behavior by the workers	Questionnaire
	Management commitment to safety	Questionnaire
	Statements about safety	Interview
	Structural conditions	
	Safety standard of equipment and machines	Inspection reports
	Form and number of formal safety meetings	Minutes of meetings
	The composition of the HSC	Minutes of meetings
	Documents	
	Visible safety information	Direct observation
	Safety signposting	Inspection by health and safety advisor
	Inspection reports	Inspection by work environment authorities
	Safety climate	Questionnaire
Espoused values	*Structural conditions*	
	Formal safety policies and objectives	Direct observation
	Accident registration and analysis	Interviews/observation
	The inclusion of safety on the agenda of meetings	Interviews/observation
	Attitudes	
	Attitudes toward safety	Questionnaire/interviews
	Shared safety responsibility	Questionnaire/interviews
	Economic priority of safety	Interviews/observation
	Use of external health and safety advisors	Interviews/observation
Basic assumptions	Identified by analysis of artifacts and espoused values	

Table 2
Undertaken interventions.

General interventions	Specific pre-planned activities	Activities based on feedback
Process focused on HSC	Monthly meetings of HSC Supervisors and health and safety advisor joins HSC	Accident analysis and prevention Safety campaigns Weekly safety topics
HSO-process aimed at feedback and goal setting	Researcher plans and chairs the two annual meetings of HSO (four in total during the study period)	Safety visions and objectives Safety specific bulletin boards Safety information at works council Safety information to all workers from CEO Safety as part of staff meetings Safety part of production meetings Column on safety in staff magazine Focus on supervisors commitment to safety in day to day interactions with workers
Process with safety representatives	Workshop and monthly follow-up afterwards	Safety themes

with three individual data points. If this is the case, the Poission regression gives an IRR that expresses the lines alpha-coefficient that indicates whether the line describes an increase or decrease in interactions. STATA v.9.1 was used to calculate IRRs and perform the LR-tests, and do the trend analysis on lost time injury data.

3. The intervention process

Interventions were focused on creating more and better interactions involving safety within the company. Only the general framework of the interventions was planned in advance. This consisted of starting three processes of development in the company aimed at the HSC, the whole HSO, and the safety representatives, respectively (see Table 2). In accordance with complex adaptive system theory, the precise nature of the interventions was not specified beforehand as they were to develop through the participants self-organization based on the baseline mapping of the current interaction patterns, supervisory practices, and the motivation for change.

Baseline data showed that the company performed very poorly safety-wise and revealed a lack of management commitment to safety. Safety in general was not an important issue for management or workers, who had productivity as the dominant top priority. There were no objectives for safety performance or formal safety policies, nor were there any systematic preventive efforts. This was in part due to a very inefficient and passive health and safety organization that had no knowledge of actual safety performance and did not even resolve identified safety issues. For instance, the company had compiled 19 unresolved enforcement notices from the Work Environment Authorities over the last few years and was regularly penalized for violations of the work environment law. Likewise an audit by an external health and safety advisor, just prior to baseline, documented 110 instances of insufficient or lacking safety signposting.

However, baseline data also revealed that there was a strong motivation to change. Six months earlier, the CEO had been replaced, and the new CEO was, in his own words, 'embarrassed by the company's safety performance.' This was a very important prerequisite for the project, as top management commitment is a critical factor for creating change. Likewise, the production manager, supervisors, and safety representatives all were dissatisfied with the current state of affairs, but they were unable to create change as they did not know how to do it. So baseline showed that the necessary motivation to change was present in the company, and the CEO played an important role in agreeing to the company's participation in the study, and in expressing a need for change. However, he was not much involved in the daily safety activities, so his role was not to create change hands-on, but on a more general level to show commitment and create the right conditions for the interventions. In this way the motivation was not a sufficient condition to create the change, but caused the project's interventions to fall on fertile ground.

The content of the pre-planned interventions was further specified on the basis of this baseline evaluation and the motivation for change. Although the interventions were aimed at different parts of the HSO at the outset, in their practical implementation they were interrelated as described below.

3.1. Process focused on HSC

The first general pre-planned intervention was a developmental process with the HSC that was initiated at baseline. In Denmark, HSCs are obliged by law to hold formal meetings four times a year. To create a more active HSO, monthly meetings of the HSC were arranged, excluding July because of the summer holiday period and the two months where the whole HSO met. The HSC consisted of the production manager, two safety representatives, and the building inspector. To further improve the quality of the meetings, four new members were appointed: two supervisors (to increase line management involvement in safety), an expert consultant from an external health and safety advisor[3] (to increase knowledge of safety issues and how to solve them), and the researcher (primarily in an observatory role). The aim was to create more efficient meetings, as the HSC was described as boring, inefficient, and incapable of solving problems at baseline. Recent accidents were discussed at the meetings, but the company had never analyzed accident data to guide preventive efforts, as the conviction was that accidents could be attributed to lack of attention, thoughtlessness, and stupid mistakes by workers. This conviction was challenged by the researcher and the HSC was urged to look for patterns in accidents occurrence and search for underlying causes, instead of focusing on immediate causes. Through these discussions, a deeper understanding of accident causation gradually emerged in the HSC and at the end of the study period specific preventive measures aimed at root causes were taken after nearly every accident, and accident analyses were used to initiate safety campaigns.

3.2. HSO-process aimed at feedback and goal setting

The second general intervention was aimed at the HSO and started two months after baseline. It was based on the four compulsory formal meetings of the whole HSO during the study. The content of these meetings was planned by the researcher. The meetings were used to feedback information on current safety performance. The aim was to enlighten the HSO and use the information to specify objectives and goals for safety performance, thereby continuously creating disequilibrium due to the discrepancy between the current and the desired state. Every meeting concluded with all participants formulating specific activities to carry out between meetings to fulfill objectives. For instance,

[3] Specifically this was a consultant company that the company had been using for years to handle health and safety issues on a job-to-job basis, and the appointed consultant was the company's main contact person, with expertise in technical issues.

the first meeting, two months after baseline, was used to establish four groups, each of which focused on their own area: (a) information and communication within and emanating from the HSO; (b) management commitment to safety; (c) defining clear objectives for safety performance; and (d) role clarity within the HSO. On the basis of work in these groups, the HSO undertook specific activities to increase safety performance. The HSO also started stating clear goals for safety performance every six months, initially primarily by the CEO but later by consensus in the HSO.

Within six months of the first HSO-meeting, the formal level of information regarding safety was heightened on several parameters. First, safety specific bulletin boards containing minutes of meetings, safety goals, and safety performance data were established eight different places in the production facilities. Second, the safety manager started writing a regular column about safety performance in the house magazine. Third, management commitment to safety became visible as safety performance became a regular point on the agenda of the meetings of the works council and was also included in the oral information that the CEO subsequently gave to all workers about company status. Finally, safety performance also became a regular point on the agenda at supervisors' staff meetings and at the two weekly production meetings between the production manager and supervisors.

On the more informal level, supervisors were encouraged to include the topic of safety in their day-to-day interactions with workers. To make this enhanced safety focus manageable for the supervisors, the production manager elaborated on the safety representatives' idea of safety themes (see below) and had the safety manager come up with different weekly topics that could be the focus point for the supervisors. The production manager then briefly introduced the safety theme of the week for the supervisors each week and handed out a piece of paper giving a brief introduction to the topic (e.g., the rules regarding use of personal protective equipment).

3.3. Process with safety representatives

The third general intervention was aimed at the safety representatives' commitment to safety and was initiated six months after baseline. At baseline the safety representatives described that there was no unity in the group and how frustrating it was that management did not prioritize safety. A workshop addressing these issues was arranged for the safety representatives. It started with the safety representatives describing what a good safety representative should be, followed by a discussion of data from baseline regarding workers perception of the safety representatives, and ending with them setting personal goals for future activities. A common theme in the personal goals was to get better at getting supervisors committed to safety issues. The progress on the personal goals was subsequently discussed at their regular monthly meetings with the safety manager, which also was attended by the researcher in the study period. Progress was generally slow and the frustration toward supervisors continued. To break the deadlock, safety representatives were urged by the researcher to be more proactive, and take the initiative to safety activities instead of waiting (in vain) on supervisors' activities. This gave birth to the idea of safety themes, where a specific safety issue (e.g., the use of personal protective equipment), was a common focus area for all safety representatives for a period of time. The idea was that a common theme would help the safety representatives get into step and make it easier to get supervisors to participate. When this activity was presented to the HSC it was taken over by the production manager as described above.

3.4. Contextual factors of importance for the intervention process

When doing intervention research in real world organizations over a prolonged period of time, it is often the case that the outcome is influenced by (changes in) contextual factors. The single-case study design used in this study does not make it possible to statistically control for such influences. Instead the bias that this causes needs to be considered when interpreting the results. Two contextual factors are especially important to consider in the present study (see Table 3).

Table 3
Contextual factors of importance to the development.

Factor	Consequence	Timing
Economic boom		
Increased production pressure	Less focus on safety	During study period
Financial turnaround	Increased resources for safety	During study period
Changes in key personnel		
New CEO	More focus on safety	Six months prior to baseline
Replacement of safety manager (1)	More time for safety No financial or managerial impact	One month prior to baseline
Replacement of safety manager (2)	Less time for safety Financial and managerial impact	Fifteen months after baseline

The first factor was the economic boom that took place in Denmark during the study years (2005–07). The company usually had to dismiss workers in the fall as sales slowed down, then rehire people in the springtime when sales were high. However, this was not the case during the study period, as the company experienced historically good sales and generally could not keep up with demands. Although the company constantly tried to hire new people and the existing workforce worked overtime, the company just fell further and further behind production schedules for the better part of the study period. This had both negative and positive impacts on safety. As the production pressure was high and constantly increasing, both management and workers were sometimes inclined to lower the priority of safety. This issue surfaced in intervention activities, as it arose in the discussions at meetings and workshops, and also in the more informal conversations with managers and workers during the study period. On the positive side, the increased sales meant that the company completed a financial turnaround and started making money, and therefore it was easier to find the resources to invest in safety.

The second factor of importance was changes in key personnel. As mentioned earlier there was a new CEO in the company, but this was not the only change. The original contact to the company was established by the researcher, who planned the project with the company's safety manager. However, the safety manager was not working full-time as a safety manager, as his primary job function was in the technical department. Just prior to the study start, the safety manager resigned from the position as he felt that it would take more than a part-time safety manager to handle the company's safety. The CEO instead promoted an active safety representative to full-time safety manager, thus putting more resources into safety. However, one year later, in the middle of the study, the new safety manager was again demoted by the CEO. This was done as the production manager did not feel that the safety manager had the necessary administrative competences to do the job and develop the function. At the same time the CEO wanted safety to be more integrated with production and line management, and therefore appointed a supervisor as part-time safety manager. The consequences of these changes were again both positive and negative. Of course the full-time safety manager appointed at the start of the project had a lot more time to deal with safety issues than the part-time safety manager he succeeded, however he was still in some

Table 4
Formal meetings of the HSC and issues discussed.

	Before the project			Study period	
	Year-3	Year-2	Year-1	Year1	Year2
Formal meetings	4	4	3	8	9
Total unique issues	23	12	18	62	115
Unique issues per meeting	9.3	5.5	9.0	20.8	40.3
Resolved issues	2	2	2	32	50

Table 5
Questionnaire measures of HSO performance.

	N	Baseline	Follow-up	Diff BL-FU
HSO performance				
Feedback	158	2.83	3.16	0.33**
Involvement of workers	160	3.05	3.22	0.17**
Safety instruction	149	2.71	3.01	0.30**
Commitment of the safety representative	156	3.40	3.56	0.16*

All scores are observed means. Scale 1–5, 5 best.
* $p < .05$,
** $p < .01$.

ways perceived as a safety representative by company management, and was not given any financial or managerial authority. When the supervisor was appointed as part-time safety manager, the consequences were less time for dealing with safety issues, but more financial and managerial impact.

4. Results

4.1. Activities of the HSC and HSO

The data showed a doubling of formal meetings of the HSC in the two project years compared to the three previous years (see Table 4). This was of course due to the pre-planned intervention of monthly meetings. Of more interest was the increase in unique issues on the agenda. This increased from approximately 20 a year in the years prior to the study to 62 the first year and 115 the second study year. This increase cannot solely be ascribed to more meetings, as the mean number of unique issues per meeting quadrupled from approximately 10 to 40. Even more remarkable was the increase in resolved issues, where only two issues were resolved per year prior to the study, while 32 and 50 issues were solved in the two project years. Some of the issues resolved within the first six months of the study were the 19 enforcement notices from the Work Environment Authorities.

In the questionnaire data, all the HSO performance scales show significant improvements from baseline to follow-up (see Table 5). The workers report getting more feedback from the HSO, feeling more involved in safety, improved safety instruction, and perceiving the safety representative as more committed.

4.2. Safety-related interactions

The registration of safety-related interactions showed that the production manager did not have many safety related interactions at baseline. During the baseline month he only registered one interaction with workers and none with supervisors or safety representatives (see Table 6). This pattern did not change significantly over time, although Table 6 shows that he began having safety-related interactions with supervisors during the study period, and at follow-up discussed safety-related topics approximately once a week with supervisors.

There is an increase in the number of interactions between supervisors and safety representatives from baseline to midway (IRR = 2.35, $p = .04$) and further from midway to follow-up (IRR = 1.20, ns). The number of interactions almost triples from baseline to follow-up (IRR = 2.82, $p = .01$), however, as the LR-test is non-significant, the simplest model is a straight line showing a 58% increase in interactions from measurement to measurement (IRR = 1.58, $p = .01$).

From baseline to follow-up, supervisors increased the number of safety-related interactions with workers (IRR = 1.91, $p < .01$), which primarily took place from midway to follow-up (IRR = 1.66, $p = .02$). The best description of the data is a straight line showing a 41% increase from measurement to measurement (IRR = 1.41, $p < .01$). The safety representatives also had more safety-related interactions with workers from measurement to measurement but this increase was not statistically significant (IRR = 1.17, ns).

4.3. Safety culture

At the artifact level there is an overall improvement in the behavioral indicators. Questionnaire data show a small non-significant improvement in 'Convenience violations' by the workers, whereas there are significant improvements in both 'Top management commitment to safety' and 'Safety specific transformational leadership' (See Table 7). At the same time interviews showed that safety issues were addressed a lot more by management when giving formal statements (e.g., information meetings by the CEO and supervisors). Concerning the structural conditions, the inspection reports from the Work Environment Authorities showed that the enforcement notices that the company had at baseline regarding machinery not being up to code, had all been resolved and no new enforcement notices had been given. Likewise the composition of the HSC and the form and number of formal meetings had changed (see Table 4). Looking at the different types of documents, safety information was made available to all through the eight new bulletin boards and both safety signposting and all the problems noted by the Work Environment Authorities were up to code by follow-up. Finally, both safety climate scales showed improvements, although only 'Supervisor actions' reached statistical significance.

At the espoused values level the structural conditions changed as safety objectives were stated by the HSO during the study period and a formal safety policy was being formulated at follow-up. Also, accident analysis and registration were now used by the HSO to guide preventive efforts and plan campaigns, and safety ended up being a fixed point on the agenda of the works council and information meetings. Three of the four scales in the questionnaire addressing attitudes showed statistically significant improvements (see Table 7). There was no increase in workers' feeling of shared safety responsibility in the departments, but at the same time, the role of safety manager was changed from a staff-function at baseline to a part of the line-management at follow-up, indicating safety becoming more of a managerial responsibility. Interviews with supervisors indicated that the economical prioritization of safety was far higher at follow-up than baseline. Supervisors stated that at

Table 6
Safety-related interactions.

	No of interactions			Straight line		IRR		
	BL	MW	FU	LR	IRR	BL-MW	MW-FU	BL-FU
Internally in the HSO								
Production manager–supervisors	0	3	5	–	–	–	1.55	–
Production manager–safety rep.	0	0	1	–	–	–	–	–
Supervisors–safety rep.	8	18	24	0.28	1.58*	2.35*	1.20	2.82*
With workers								
Production manager–workers	1	0	0	–	–	–	–	–
Supervisors–workers	31	34	63	0.36	1.41**	1.15	1.66*	1.91**
Safety representatives–workers	37	51	60	0.49	1.17	1.03	1.31	1.35

* $p < .05$,
** $p < .01$.

Table 7
Questionnaire measures of artifacts and espoused values.

	N	Baseline	Follow-up	Diff BL-FU
Artifacts				
Behavioral indicators				
Convenience violations	166	3.12	3.19	0.07
Top management commitment to safety	165	2.91	3.09	0.19**
Safety specific transformational leadership	123	2.28	2.44	0.16*
Safety climate				
Supervisor expectations	166	3.31	3.41	0.11
Supervisor actions	163	2.74	2.89	0.15**
Espoused values				
Attitudes				
Workers safety priority	164	3.79	3.92	0.12*
Safety oversights	166	3.35	3.55	0.20**
Organizational value of safety	164	3.45	3.75	0.30**
Shared safety responsibility	165	3.71	3.74	0.02

All scores are observed means. Scale 1–5, 5 best.
* $p < .05$,
** $p < .01$.

baseline there was no money for safety, but at follow-up it was seen as a shortcut to getting problems fixed, if it could be labeled as a safety problem. Interviews also indicated a different approach to external health and safety advisors, who at baseline were seen as a nuisance and linked with confrontations and control. At follow-up they were still seen as performing a controlling function, but also as necessary sparring partners in the safety effort. The development in the different safety culture indicators across measures is summarized in Table 8.

4.4. Lost time injury rates

Sixteen lost time injuries were reported in the first study year, while 12 were reported the second year, compared to 18 the year prior to the study. The development in lost time injury rates during the study period and the previous four years is shown in Fig. 1. Trend analysis showed a significant increase in the lost time injury rate (IRR = 1.27, $p > .01$) during the four years prior to the study, while there is a non-significant decrease in the rate during the intervention period (IRR = 0.82, $p = 0.10$).

Table 8
Overall development in safety culture indicators across measures from baseline to follow-up.

Cultural layer	Indicators	Change
Artifacts	*Behavioral indicators*	
	Unsafe behavior by the workers	Unchanged
	Management commitment to safety	Higher
	Overall safety orientation	Higher
	Structural conditions	
	Safety standard of equipment and machines	Higher
	Form and number of formal safety meetings	More meetings
	The composition of the HSC	Improved
	Documents	
	Visible safety information	Bulletin boards
	Safety signposting	Up to code
	Inspection reports	Up to code
	Safety climate	Higher
Espoused values	*Structural conditions*	
	Formal safety policies and objectives	Established
	Accident registration and analysis	Used for prevention
	The inclusion of safety on the agenda of meetings	Safety part of meetings
	Attitudes	
	Attitudes toward safety	Higher
	Shared safety responsibility	Unchanged
	Economic priority of safety	Higher
	Use of external health and safety advisors	More positive

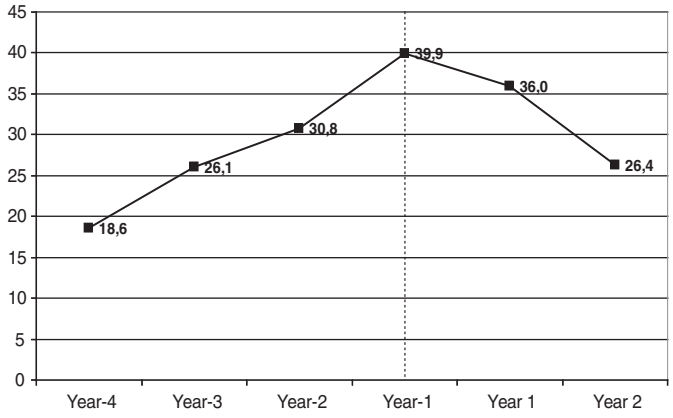

Fig. 1. Development in lost time injury rates during the study period and the previous years (injuries/million hours).

5. Discussion

The aim of the current project was to test an HSO-approach focused on improving safety culture by improving safety-related interactions. The interventions aimed at improving safety-related interactions by creating more and better interactions, both on the formal (e.g., creating more meetings of the HSC, involving relevant persons) and informal level (e.g., focus on safety in supervisors' daily interactions with workers).

5.1. HSO performance

At the formal level, the results from the minutes of the meetings of the HSC (Table 4) are indicative of a more efficient HSC, which was able to resolve safety issues. This is in line with Morse et al.'s (2008) results that effective HSCs review a larger number of complaints and suggestions. In the follow-up interviews this development was to a large degree ascribed to the inclusion of supervisors and the health and safety advisor in the HSC, as well as the frequent meetings. At baseline the HSC did not know how to solve identified safety issues, but after the inclusion, the health and safety advisor was able to recommend solutions and thereby get the HSC to take action. Furthermore problem solving was far easier as supervisors, who often were the ones responsible for the practical implementation and follow-through, also were present in the HSC. Questionnaire data on perceived HSO performance (Table 5) strengthen this interpretation, as marked improvements were seen in every area. This development is, as would be expected, based on international evidence that suggests that changes in the size, composition, process and activities of HSC lead to better safety performance (Geldart et al., 2010; Liu et al., 2010; Milgate et al., 2002; Morse et al., 2008).

5.2. Changes in interaction patterns

At the informal level the registration of safety-related interactions (Table 6) showed an increasing number of interactions during the study period, within the HSO and between supervisors and workers. This might indicate that more safety related interactions were created as a result of the interventions. However, two other explanations for this increase might also be plausible. First of all, the registration of interactions only covered interactions where the participants were aware of safety issues being discussed. If the participants became more aware of safety issues during the intervention process, the increase in safety-related interactions might be an indicator of increased safety awareness and not increased interactions (i.e., there was no change in interactions, only the participants' perception of the interactions changed). Secondly, the participants might deliberately have engaged in more safety related interactions during the registration period, because they were aware of the registration taking place (i.e., a type of test-effect). However, in the

follow-up interviews, it was clearly indicated that safety had become a topic addressed by top management in their interactions with supervisors, which also was evident from the use of weekly safety topics. Supervisors, safety representatives, and workers (who were not part of the registration and thus not affected by any test-effect) also all expressed having more safety-related interactions than before. So although other interpretations are possible, the most plausible explanation seems to be that there in fact was an increase in safety-related interactions during the study period.

At the same time the more efficient HSC contributed to the safety-related interactions being more fruitful, as the ability to identify and handle safety issues was increased. Put together, these results indicate that more and better safety-related interactions were created during the project period.

5.3. Changes in safety culture indicators

According to the study's culture change strategy, creating more and better safety-related interactions would stimulate self-organization from which new attitudes and cultural patterns would emerge. In Schein's understanding culture change equals changes in basic assumptions (Schein, 1990). However, such changes are not easily identified, as the basic assumptions are unconscious and not readily accessible. The changes have to be derived through an analysis of the outer layers of culture. So to identify cultural change we need to analyze the artifacts and espoused values at baseline and follow-up, respectively.

At baseline the artifact level showed signs of low safety commitment. Behavior was generally unsafe, with low worker and management commitment as indicated by interviews and questionnaire data. At the structural level the company was not performing very well either. Several of the Work Environment Authorities enforcement notices concerned machine safety such as insufficient safeguarding or missing emergency stops. Furthermore, the meetings of the HSO and the HSC were unstructured and inefficient as was the composition of the HSC. Likewise, the espoused values showed low safety priority. There were no objectives for safety performance or formal safety policies, no accident analysis, and safety was only discussed on the meetings of the HSC. This reflected the general attitudes to safety from management and workers, where no or very few resources were spent on safety and external advisors were unwanted.

At follow-up a lot of things had changed and both the artifacts and the espoused values point to safety becoming more salient. Supervisors and the CEO now talked about safety at staff meetings, and questionnaire data showed improvements in the safety commitment of management and safety representatives. At the document level, safety information became much more visible because of new initiatives such as the safety managers column and the safety specific bulletin boards in the production areas. At the same time, safety signing improved markedly, as the company reacted on the aforementioned written report pointing at 110 different places with insufficient or lacking safety signposting. At baseline the unresolved enforcement notices and the report on insufficient or lacking safety signposting were documents pointing at a company with low safety performance. All these issues were resolved at follow-up, and there no longer existed any reports, enforcement notices, or other documents testifying to low safety performance. On the contrary, when the Work Environment Authorities did a surprise work environment inspection midway through the project, as part of a national screening of all Danish enterprises, the company's rating changed from the worst to the best category, indicating a marked improvement in performance.

Company lost time injury data also showed a changed trend in the intervention period compared to the four years prior to the study. Although the data showed a decrease in injury rates, this was not statistically significant, which is mainly due to lack of statistical power. As a general rule, such injury statistics have to be interpreted with caution though, as underreporting is always an issue. However, taken together with the development in the safety culture indicators mentioned above, it seems plausible that the changed trend in injuries is genuine.

5.4. Did the basic assumptions change?

The results indicate changes at the level of artifacts and espoused values. However, changes in artifacts and espoused values are not sufficient to conclude that the culture has changed. They might only indicate changes in surface manifestations such as behavior, climate, or policies. According to Schein (1990) changes in culture can only be verified by identifying changes in the basic assumptions. These are changed through double-loop learning, which is defined as a strategy where the governing values behind actions are questioned and changed when actions fails, and stands in contrast to single-loop learning where new actions are chosen within the same governing values (Argyris, 2004; Argyris & Schön, 1996). If we look at the changes from baseline to follow-up, they could be taken to indicate that double-loop learning has taken place. At baseline the pattern of results across artifacts and espoused values reflected that management was not committed to safety and no or very few resources were used on safety or external assistance, although safety problems were clearly evident and directly observable for anyone (e.g., fines from Work Environment Authorities). This point at the basic assumption being that safety is to be ignored (as productivity is more important).

However, at the start of the study period, it was not possible to ignore safety issues any longer, as the accumulated enforcement notices and fines forced the company to spend resources on safety. What is interesting here, is how this cultural conflict (safety ignored $\asymp$ not able to ignore safety) was handled. If it was handled using single-loop learning (thus not questioning the governing value of ignoring safety), the company could have paid external consultants to come and fix the specific problems that caused the enforcement notices and fines. Afterwards the company would then be able to go back to ignoring safety. However, that was not what happened. Instead the company questioned the governing value of ignoring safety. They used resources to identify the basic causes of the company's safety issues. The company then addressed these issues and tried to improve management commitment to safety, the economical priority of safety, and safety knowledge and skills. This is indicative of double-loop learning, where the basic assumptions are challenged and changed. An analysis of artifacts and espoused values at follow-up reflects a new state of affairs. At follow-up management was (more) committed to safety, safety issues were dealt with in a competent manner, and resources were spent on safety issues and external advisors. This is indicative of a new basic assumption that safety warrants the necessary priority to be handled in a proper way (while still recognizing that production is the most important thing).

Thus the cultural analysis can be interpreted as showing double-loop learning that has caused changes in the basic assumption. However, does that mean that the culture changed? Double-loop learning is necessary for cultural change, but does not guarantee cultural change in itself. A close inspection reveals that not all the collected data supports a cultural change conclusion. For instance questionnaire data showed no change in convenience violations from workers, who also did not feel a greater shared responsibility for safety in their department. Likewise, productivity stayed the top priority for the company all through the project. So was there an improvement in safety culture? Well, first of all it is important to recognize that culture is not necessarily homogeneous and unambiguous — especially in times of change. So it is not reasonable to expect the data to be clear-cut. Secondly, when dealing with a complex construct such as (safety) culture it is also not feasible to expect to find one single indicator to measure change with. There is no smoking gun. Instead a multi-method approach allows for interpretations of the pattern in the data. And it is by looking at the pattern in the data that cultural change can be rendered probable. It is true that we do not see changes in convenience violations and shared safety responsibility, but if we look at other parts of the data, there was an

increase in workers' safety priority and both supervisors and safety representatives indicated in the interviews that they saw the workers as more committed to safety at follow-up. Furthermore, the question is whether safety needs to be more important than production before a change can be identified. A change from safety being ignored to safety being seen as the second or third priority in the company is still an improvement.

Lastly the contextual factors have to be taken into consideration. The identified development took place during a period when the company experienced a historically high production pressure and had replacements and redefinitions of roles among key safety personnel. The fact that an improvement in the priority of safety could be identified under these far from perfect conditions indicates that the interventions have been quite powerful and that the commitment from the involved parties has been quite high.

Overall the pattern of the results supports an interpretation stating that the changes in the safety culture indicators are indicative of actual safety culture changes, as a double loop learning process leading to changes in basic assumptions could be identified.

5.5. Limitations and contributions of the study

The study has several limitations. First of all, an intervention strategy based on complex adaptive systems theory, which emphasizes self-organization, unpredictability, and uncontrollability, does not easily fit into common scientific standards of pre-specification and control of interventions. However, in organizational research adaptive research strategies are often warranted to accommodate the real world changes in organizational life. Furthermore, the intervention strategy in the current study was continuously developed based on the collected data and in interplay with the participants, which is a well established intervention method within action research. The detailed description in part 3 makes the intervention process transparent for anyone wanting to judge the feasibility of the intervention.

Secondly, the multifaceted nature of the interventions also means that it is impossible to isolate the effect of the single elements in the intervention. The intervention consisted of three interrelated general developmental processes, which as indicated in Table 2 ended up in a lot of different activities being undertaken. It is not possible to determine which activities were effective and which were not. However, it might be questionable whether it is at all of interest to isolate the effects of single interventions. Complex adaptive systems theory sees organizational development as the result of numerous small events rather than a few large critical events (Dooley, 2002), and the complexity of (safety) culture change makes it improbable to find any effect of one single simple intervention. This is substantiated by reviews of the safety intervention literature, which concludes that multifaceted efforts are the most effective (Guastello, 1993; Lund & Aarø, 2004).

Thirdly, the quasi-experimental and single-case design of the study makes it impossible to infer causality. So even if the interventions are performed satisfactorily it is not possible to infer that the cultural changes happened because of the interventions. The changes might have happened due to other factors not measured in or related to the study. Although the study incorporated many different factors the conclusions need to be substantiated by further research with designs better suited to establish causality. However, the in-depth nature of this study makes it very well suited to be used as a starting point for further research.

Finally, the unconscious nature of the basic assumptions makes it hard to verify whether cultural change has taken place at all. It becomes a matter of interpretation based on a heterogeneous pattern of results, which is not an exact and objective science, but instead is a matter of theoretical and analytical point of view. This is a common problem with all (safety) culture studies, due to the lack of common definitions and understanding of the culture phenomenon. The current study has tried to overcome this, to some extent, by building on well-established theories from organizational and safety science.

Although the study has these limitations it is felt that it can still be a valuable contribution to the scientific literature on safety culture interventions, as this literature is very sparse. The primary contributions of this study are both empirical and theoretical. The study's approach to change was primarily leader-based grounded in Schein's and Zohar's emphasis on leaders' pivotal role in creating cultural and climate change. The link between safety climate and safety outcomes is well-established, but the relationship to other constructs, such as culture, is unclear (Zohar, 2010). Zohar has previously shown that leader-based interventions aimed at safety-oriented interactions can create improvements in safety climate and workers' safety behavior, that continues beyond the post-intervention period (Zohar & Luria, 2003). The current study adds to this both empirically and theoretically, by linking such sustained changes in interaction patterns to culture change, thereby attempting to bridge the climate–culture gap. Furthermore, the notion of transformational leadership is underlying both Schein's and Zohar's understanding of organizational change and although both Schein (2004) and proponents of transformational leadership (Bass & Riggio, 2006) emphasize the pivotal role of leaders in creating culture change, there is a lack of empirical evidence supporting this notion — especially within safety science. The current study bears some evidence for this relationship, as marked improvements in top management's commitment to safety and the safety-specific transformational leadership of supervisors are linked to culture change.

6. Conclusion

The current project adds to the safety literature, not only in providing a rare case study on safety culture intervention, but also by showing some evidence for the link between leadership, safety climate, and culture. The study shows that the HSO can improve company safety culture by creating more and better safety-related interactions both within the HSO and between HSO members and the shop-floor. Results indicated a marked improvement in HSO performance, interaction patterns concerning safety, safety culture indicators, and a changed trend in injury rates. These improvements are interpreted as cultural change because an organizational double-loop learning process leading to modification of the basic assumptions could be identified. However, due to the single-case design of the study it is not possible to infer causality.

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Kent Nielsen (PhD-2008, psychologist, deputy head of department) works in the Department of Occupational Medicine at Herning Regional Hospital, Denmark. He is actively involved in the fields of safety intervention research, the measuring and managing of safety climate and injury epidemiology.